CHAPTER XXIII

Notes on Arrow Making

By Z. E. Jackson

THE construction of a good arrow requires attention to so much minutia and detail that it seems almost a hopeless task to attempt to describe the many operations in a single chapter. It will be understood in the beginning that this is not intended as a lexicon or an archery dictionary and if the weight of a bow is mentioned as being 50 pounds it does not mean that that bow, if laid upon the scales, would register 50 pounds in weight. Likewise, if an arrow is referred to as 4–6, meaning 4 shillings 6 pence, it does not refer to the cost of the arrow but to its weight. Where the superlative "best" appears it does not mean that the particular method or material referred to as being best is the best that the art or market has ever afforded, but is the best within the experience of the writer. If the name of a dealer in materials is used it is for the purpose of giving to the lovers of archery

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the benefit of much research in the market, and not for the purpose of advertising any particular firm.

One of the difficulties met by amateurs in the manufacture of their archery tackle is the lack of information as to where materials may be secured. If reference be made to some particular method adopted by commercial arrow makers it is for the purpose of comparison and not with the spirit of finding fault. I shall probably overlook many important details but no suggestion here made can be profitably omitted.

Of the numerous books on archery that I have read,—and my reading has covered practically the entire field—I have yet to find a single one that gave definite instructions that would be of benefit to the amateur. They all call attention to most of the requirements and then fail to state how to secure the necessary result. They speak of cutting a feather as though no more skill were required than in clearing the back yard of weeds. Glue is just glue without information as to which kinds are best adapted. English deal is referred to as a particular kind of wood, but so far as I am able to learn from inquiry

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of the tradesmen, deal is an English expression denoting dimension lumber. I might fill a chapter with reference to the generalities used by writers in attempting to describe the making of an arrow but it would be to no good purpose. I shall endeavor to set down what information I have secured in a long-continued effort to learn the mysteries and secrets of the old arrow makers and which they have apparently guarded with jealous care. I do not wish to be understood as saying that the methods described are the only methods which will give good results; what I do assert is that if the instructions are followed the product will be an arrow of which no man need be ashamed in field or tournament.

Inasmuch as there are many points of similarity between a target arrow and hunting arrow I shall first describe the method of making a target arrow and will then refer to such changes as are made necessary by the difference in use of the target and hunting arrow. I make no reference to the weights of either kind as that depends upon the individual choice and strength of the bow used.

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The material used for the shaft of the target arrow is invariably some species of pine with a hard material for a nock to prevent splitting, and a wood harder and heavier than pine for the footing. In a fourteen years' search I have never been able to secure a good piece of pine. I have tried hard pine, yellow pine, Western pine, Southern pine, spruce and Oregon fir. A clear piece of close, vertical grain hard pine flooring is fair material, but the best American wood is Oregon fir, care being taken to select staves in which the grain is very fine and does not run out of a 3/8 of an inch square stave in 28 inches. Needless to say, the material should be well seasoned but not kiln dried. Kiln dried lumber is as useless for archery tackle as driftwood. That end of the pine stave which will be footed is then planed down on two sides, a distance of 5½ inches from the forward end and brought to a feathered edge of a thickness equal to the saw slot in the footing hereafter mentioned. This work is best done by hand and instead of placing the stave on a bench and planing it, the plane is held in an inverted position in the vise and the stave planed by drawing it over the plane. The

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pressure required bends the thin edge of the stave producing a result very much as in the hollow ground razor; that is, the edges of the wedge are not a straight line but a curve.

The footing may be of any hard, heavy wood. Beefwood does not work well under the plane; the grain is gnarly like maple. Snakewood makes a beautiful footing but does not hold the glue without special treatment. Lancewood does not give the desired contrast in color; mahogany is too light in weight; ebony is too brash; the many different kinds of rosewood are too light; amaranth is best. It takes glue and still works perfectly under the plane or the rasp or in the lathe. It may be secured from any of the hardwood dealers in the large cities, Boston, particularly. It is usually sold by weight and costs from 40c to 75c a pound, according to the avarice of the dealer. The footing is cut 8 inches long and 3/8 inch square. It is slotted from one end a distance of 5 5/8 inches. The making of the slot is more or less troublesome. It may be done with a hacksaw in which the blade is set at right angles with the frame. A backed saw will not reach the depth of the slot. A good hand tool for cutting the slot is made

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on the order of a Chinese saw, which has a rectangular shaped frame with the handle on one end and a hacksaw blade secured lengthwise in the rectangle. This permits the material to pass up through the frame without obstruction. If you have power, a five inch Disston cabinet-maker's circular saw is the best. It has no set, being thicker at the periphery than at the center. It leaves the work free from kerf and almost as smooth as if planed. If a circular saw is used the very bottom of the slot must be squared with a few strokes of a thin hacksaw blade.

The contact surfaces of the wedge and the slot are then covered with a good glue and the wedge forced into the slot, in doing which the footing is clamped in the vise up to the bottom end of the slot to avoid splitting. Before being removed from the vise clamps are applied and set firm. No fewer than three clamps for each footing should be used. More would be better. A very convenient and efficient clamp for this purpose may be made from bar steel bent into the shape of a U, provided with a $\frac{3}{16}$ inch stove bolt for a screw. The glue should be permitted to dry at least 24 hours. Any good quality of

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glue will do for this purpose so long as it is well dissolved and in good condition. While on the subject of glue, I wish to say that for gluing on the footings LePage's liquid glue is good. There are frequent delays and adjustments that often permit hot glue to become cold and to "cheese." The best glue I have found for this part of the work is a liquid fish glue made by the Imperial Glue Company of San Francisco. With the exception of a special glue, which will be hereafter mentioned in connection with feathering, the Imperial glue is the best I have ever found for all 'round archery tackle work.

After the clamps are removed from the footing the wings of the footing will extend beyond the sides of the shaft $\frac{3}{16}$ of an inch. These extensions should be planed off until the shaft again assumes its dimension of a straight stave $\frac{3}{8}$ of an inch square.

A grooved board, such as a piece of flooring, 36 inches long, is held in the vise with the groove uppermost in which a wooden stop near one end has been provided. The stave is laid in the groove and the four corners planed until the stave is reduced to a true octagon. The corners of the octagon are

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then removed in the same way and so on until the stave has been reduced to a true round. It is then further reduced with varying grades of sand paper, in doing which the arrow is given a decided spiral or rotary motion.

A power driven tool on the order of a dowel cutter is best for turning the shaft, in case the maker chooses to use a machine process.

It is best to make 18 or 24 arrows at a time. Some will turn out bad, some be ruined. The staves, although taken from the same stick, will vary in weight, often as much as 10 grains, depending upon the thickness of the year marks.

After reducing all shafts to practically the same size they are cut to the same length and the nock end of the shaft is provided with a V shaped slot for receiving the nock, which is placed there to prevent splitting by the string. The making of that slot is troublesome. It may be done by holding the rounded shaft in the vise, having provided a split block in which a hole has been bored approximately the size of the shaft, and which is used as a clamp in the vise to avoid bruising

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the shaft. A fine tooth hacksaw may be used. By fine tooth hacksaw I mean one made for sawing tubing, in which the teeth are double set; that is, two teeth are set to the right and then two to the left. The best one is the Globe, on sale by all first-class hardware dealers. Later I will refer to a coarse hacksaw which has the single set, such as the well-known Star. It goes without saying that a hacksaw, to be of service in working wood, should never be used on metal.

The slot for the nock may be sawed out carefully and finished with a knife-edge file. I have, however, long since abandoned that plan and instead use a circular saw specially made by myself for that purpose. It is 4½ inches in diameter, has regular saw teeth on the periphery, on a cross-section of one-half of which shows the V shape, the saw being ⅜ of an inch thick at the center and brought to a feather edge at the periphery. Long slots are cut in the saw on a tangent with a circle, the periphery of which is ¾ of an inch outside of the mandril hole. These slots are four in number and are themselves provided with teeth, the clearance being secured by grinding away the metal back of the teeth.

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I realize that this is an imperfect description but I am endeavoring to describe the process without the aid of drawings and illustrations. The saw mentioned is driven at about 3,000 R.P.M. and although crude in appearance and design does the work well and almost instantly, whereas the making of the slot by hand is tedious and unsatisfactory and is often the cause of ruining partially completed shaft.

Various materials, including hard wood, horn, shell, bone, ivory, and metal, are used for nocking the arrow but the ordinary red wood-fiber, such as is extensively used in electrical work, is the best. It takes the glue well and gives the desired contrast in color, besides being exceedingly tough. The notch for the string should, however, be made across the grain. I have never known a fibre nock to split except when struck by another arrow. The nock is first reduced to the shape of a wedge 1¼ inches long and approximately the size of the V shaped slot made to receive it and be readily worked into shape by sawing with a fine tooth backed saw. A coarse hacksaw is better. The best plan, however, is to secure a strip a foot long and

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3/8 of an inch thick and 1¼ inches wide, glue or screw the strip flatwise with brass screws on a strip of wood, which has been beveled on one edge at such an angle that when the wood is flat on the saw table a vertical line will pass from the corner of one edge to the opposite corner on the other edge and divide the strip of fiber in two long wedge-shaped sections. With a fine-tooth, cross-cut, circular saw, rip the strip of fiber from one end to the other. The brass screws will not injure the saw. This will produce the long, wedge-shaped strips referred to and sections may be readily cut therefrom with a coarse hack or backed saw or on the circular saw, and which sections are approximately the shape of the nock to be placed in the V shaped slot. This method saves a vast amount of work and produces nocks of uniform size. The contact surfaces of the fiber and of the slot are then covered with glue, the fiber inserted in the slot and clamped as with the footing until the glue has thoroughly dried.

The result of the foregoing operations is a round shaft approximately 11/32 of an inch in diameter and of a length best suited to the archer, which under no circumstances should

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be more than 28 inches unless the archer possesses arms of unusual length and uses a bow longer than six feet. I hold that a six foot bow of the type of the English long bow, drawn more than 28 inches is abused and will not last. The shaft as so far finished will produce an arrow of approximately 5 shillings in weight, which is too heavy for a bow under 55 pounds. For weaker bows the shaft should be reduced in diameter. The rounded shaft is again placed in the grooved board and the nock end given a gradual taper with a very light cutting plane, or a wood rasp or mill-cut file, beginning 6 inches from the nock end and gradually tapering to a diameter of $\frac{9}{32}$ of an inch at the extreme end of the nock. The nock end is then rounded with a fine mill-cut file, or what is best a coarse emery wheel.

The notch for the string may be made in numerous ways, either with two cuts of a coarse hacksaw and then finished with a round-edged, flat file, or with a circular saw 4 inches in diameter and equal in thickness to the finished notch and rounded on the periphery to conform to the notch to the bow string. Such a saw must be kept sharp and

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travel at a high rate of speed, 3,000 or more. Otherwise it will tear the fiber. In cutting the V shaped slot it should be cut with the grain of the shaft. This will permit the string notch to be cut at right angles with the grain of the shaft, thereby permitting the arrow to ride the bow on the edge of the grain rather than on the flake. This is essential for two reasons. The arrow is stiffer in that direction and withstands the slap on the bow better. The other reason is that the arrow will not wear away as it would if it rides the bow on the flake. The notches in all arrows should be $\frac{3}{16}$ of an inch deep and uniform in width. They should so fit the bow string as to support the weight of the arrow when placed on the string and suspended therefrom, but the string should be made to fit the notch instead of attempting to make the notch fit the string.

The pile or arrowhead is a thimble made of steel $\frac{7}{8}$ of an inch long. They may be secured from E. I. Horsman & Company or of Mr. James Duff, manufacturer of archery tackle, or possibly from Abercrombie & Fitch of New York, who I understand have added archery tackle to their stock. I have never

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been able to secure a satisfactory pile. I make my own, using cylindrical sections of the required length cut from Shelby steel tubing. A pile which is a section of a true cylinder is not good; it opens a hole in the target the full size of the shaft and permits the arrow to pass entirely through the target, especially if the target be an old one. The pile should be 1/32 of an inch less in diameter at the front end than at the back. This result is secured by swedging, which may be done without heating the tube. The swedge is made by boring a hole of the required size in a block of steel or brass, then reaming it with a tapered reamer. The mandrel is hardened steel of the size and shape which suggests itself from requirements. Small conical shaped points are turned from steel (cold-rolled shafting works fine); a shoulder is turned on the end of the cap so that it sets into the shell 1/32 of an inch and shoulders up against the end of the shell. The cap and the shell are then soldered together. Brazing is better but unnecessary. In soldering, abandon the different acid solutions. Use any good soldering paste, that may be secured from electrical supply dealers. The

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caps and the shells must be carefully tinned before attempting to solder.

The pile is fitted to the end of the shaft according to the tools and conveniences at hand. The best way is with the assistance of a hollow spindle lathe, but great care should be taken to see that the pile is perfectly "stopped;" that is, the end of the shaft should come in contact with the cap of the pile and the shoulder of the shaft should meet the end of the shell, when the pile is driven home. The pile can be retained in position by glue applied to the shaft, care being taken to not use too much, otherwise the pile cannot be driven to its proper place. If it becomes necessary to remove the pile apply a flame for a short period. The gas formed by the heated glue will cause the pile to detach itself.

The shaft is again placed in the grooved board and the point of union between the footing and the pile is dressed with a mill-cut file, after which the point of the pile is dressed on the emery wheel.

At this point I wish to suggest that a tool of great convenience and utility can be easily made in the form of a wooden device carrying a handle like a plane which will clamp flat

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files in such position as they may be used in the same manner as a plane.

After all the shafts have been brought to the condition now referred to they are weighed upon a jeweler's balance scale until the lightest is discovered. That one should be then worked down to the desired weight and placed in the scales and all other shafts brought to equal weight. This process of reduction and weighing out is as tedious as it is important and may be performed with files, steel wool and varying grades of sand paper. The acme of finish may be secured by the use of glasspaper, which can be obtained from dealers in musical instruments and violin makers' supplies. The glasspaper leaves a finish that cannot be approached by the use of abrasive agents such as sand or emery paper, or steel wool.

Immediately after being brought to weight and before they have had opportunity to accumulate moisture the shafts should be varnished from the pile to a point within 4½ inches of the extreme nock end. The alcohol varnishes, such as shellac are tabooed and should be avoided. They are worse than useless. Spar varnish, any of the varnishes used

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on bamboo fishing rods, or a good grade of rubbing varnish, which may be secured from any first-class carriage painter, may be used, but the best is what is known under the trade name of "chinamel" made by the Ohio Varnish Company. The first coat should be thinned with turpentine. The varnish used must fulfill many requirements. It must cling to a highly polished surface, must not crack under changing weather conditions, must respond to treatment with steel wool and other abrasives without gumming or balling, and at the same time must set with sufficient hardness to prevent becoming soft under the influence of frictional heat as the arrow passes into the target.

After receiving the initial coat of thin varnish the shafts are kept in a dry place for 24 hours when they again go through the weighing out process, in which they are again rubbed down with the finest grade of steel wool. No sand paper should be used; the dust will fill depressions and appear under the succeeding coats of varnish. That portion of the shaft which has not been varnished and which is called the "shaftment" is then sized with extremely thin glue and permitted

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to dry 6 hours. The application of the thin glue will raise the grain, which must be removed by a very light application of the fine steel wool. In applying the size, care should be taken to not cover any of the varnished portion of the shaft. If this occurs the succeeding coats of varnish will flake off. The purpose of the size will be very apparent when the operation of feathering the shaft is attempted. Without it the bare wood of the shaft will rob the feather of its glue and in addition to this the glue of the feather will not take hold of the bare wood instantly as it will if the size is used.

The fledging or feathering of an arrow, requiring as it does the securing, selection, cutting and attaching of the feather, constitutes the most difficult part of arrow making, and as frequently remarked by my good friend Challiss, is not a matter of skill but is an art.

Preëminent among feathers for a target arrow are those of the peacock, but they are almost impossible to secure. Next comes that of the domestic turkey. While the white turkey feather will not stand as much abuse as the gray, I prefer it because of its greater

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beauty and the fact that it can be dyed to any desired color. In attempting to dye feathers great care should be taken. If the solution is too hot it will ruin the feather. I might say that I ruin two of every three feathers I attempt to dye. Any commercial dye may be used.

What are known on the market as primary feathers or "pointers" are selected, care being taken not to select the feathers from opposite wings of the bird. They should also be selected with reference to their size and texture and if the stock on hand will permit, the portion used for fledging should come from the same part of the feather; that is, the three vanes used on an arrow should be taken from three separate feathers but from the same location for the reason that a primary feather is coarser and stiffer near its middle than at either end. Each wing on an arrow should be of precisely the same size, texture, weight and strength. A heavy vane and two light ones will have the same effect upon the flight of an arrow as would a large one and two small ones.

Feathers become seasoned and exceedingly tough and difficult to work and at a certain

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stage of the preparation must be rendered tractable by the application of moisture in some form referred to later. All tools used in preparing the feather must be sharp, and by this I do not mean approximately sharp. The knife that would not comfortably shave the user is not sharp enough for this purpose, and the tools must be given constant attention that they may not become dull. The feathers for a target arrow should be cut and not stripped from the bone. Using stripped feathers is but a makeshift and indicates inattention to the details so essential to final success. After the feather is selected it should be ripped lengthwise through the groove in the nether side of the bone. If the vanes are to be of the ordinary balloon shape they should be $2\frac{3}{16}$ inches long and $\frac{15}{32}$ of an inch high at the highest point. After the feather has been ripped the wings may be cut from the broad side by a die made of sheet steel, the feather being placed on a maple block and the die struck with a light hammer, care being taken not to injure the bone. Three wings may be secured from one feather and after being stamped out there will be a space between each wing, as it

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adheres to the bone, of about ½ inch. The die mentioned may be made from an old handsaw blade or a cabinet maker's scraper, which can be bent into shape without the application of heat. It is then sharpened on the emery wheel to a chisel edge.

The vanes as stamped are then separated by cutting the bone so as to leave ⅛ of an inch extending beyond each end of the wing. It will now be noticed that while the wing is in its final shape there is far too much bone attached to it and this excess of bone for convenience is described as follows: That portion which lies in the same plane with the cane is "A;" that portion which lies in a plane at right angles to that of the vane is "B." The surplus at "B" is removed by being held in a clamp and cut with the blade of a safety razor. The clamp is in the form of an ordinary butt hinge having three leaves and is made preferably of aluminum to avoid dulling the knife. The two outside leaves are of strong metal, reinforced with wood to prevent bending or giving under the strain. The middle leaf is made of very thin aluminum or brass about 36 gauge. The feather as stamped is placed in the clamp with the vane

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firmly held between the middle leaf and one of the outer leaves of the clamp. The safety razor blade is then inserted between the middle leaf and the other outside leaf of the clamp in such manner that the middle leaf lies between the blade and the vane of the feather. A single stroke of the blade suffices to remove the surplus bone at "B" and the vane of the feather is protected, by the intervening middle leaf, from damage during the operation. The result is that the surplus bone left at "B" will be equal to the thickness of the middle leaf in the hinged clamp. There is still far too much bone at "A," the removal of which gives no little trouble. The following plan is the result of many experiments both in method and with mechanical devices.

As before stated, the feather becomes seasoned and tough and at this stage it is necessary to soften the bone by the application of moisture. In fact, that may be done before removing the surplus at "B" but it is not so essential. A shallow pan is so arranged over the gas flame that water placed therein will be slowly evaporated. The pan has a cover of galvanized wire screen. A piece of heavy cloth (an old bath towel is good) is

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wrung out of hot water and then laid on top of the screen in such manner that the vanes as stamped out may be arranged on top of the cloth and then covered with a fold of the same cloth. The heat and moisture from the cloth, to which is added the heat and vapor from the evaporating water, will in 10 or 15 minutes render the feathers soft and pliable. As needed, they are removed from the steam bath, care being taken to keep those not in use covered with the extra fold of the cloth. One vane is removed from the steam bath and laid upon a smooth, soft pine board, crosswise of the grain of the board. Lack of attention to this apparently small detail will absolutely baffle any attempt to cut the bone of the feather "A," which is the desideratum. The vane is held on the pine block with a straight edge 4 inches long, ⅜ of an inch thick and 1¼ inches wide, brought to a beveled edge in the form of an ordinary ruler. The sole purpose of the straight edge is for the purpose of holding the vane firmly in position while being cut. The knife does not touch the straight edge during the process of cutting. The straight edge is placed on the vane and the straight line of

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the bone left in removing the surplus at "B" is pressed firmly and accurately against the straight edge and the surplus bone at "A" is removed by a single stroke of the knife guided only by the eye. The best knife for this purpose is made from an old-fashioned razor blade 5/8 of an inch wide, the point of which has been left at right angles and not rounded and to which blade has been affixed securely and firmly a wooden handle according to the individual desire of the fletcher. In operation, the point of the blade passes through the bone and into the soft pine board and assists in guiding the knife. It will therefore be readily seen that if the cut were made with the grain of the pine board the knife would follow the grain of the wood and be deflected. It is possible to make this last and most important cut by several successive strokes of the knife but the result is never so satisfactory. It should be done at a single stroke. Should the result be other than a perfectly true line the following makeshift may be resorted to. Replace the vane in the hinge clamp, bring the surface of the bone at "A" to a true line by filing it with a file made by gluing a strip of sharp sand paper

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(00 grade) on a stick 8 or 9 inches long and 3/8 of an inch square. I have heard of arrow makers who instead of cutting their feathers remove the surplus bone by holding the vane in a clamp and planing off the surplus with a tiny violin maker's plane. I have tried it without the slightest degree of success. After the final cut the vane is restored to the vapor bath where it remains until the balance of the vanes receive the finishing cut.

There are numerous methods of gluing the vane to the shaft. One is by temporarily wrapping them on with thread. This is the poorest possible method and unworkmanlike. Another way is by placing the vane between the leaves of a clamp such as would be formed by an ordinary butt hinge and pressing the glue-covered surface of the bone against the shaft. This requires too much manipulation, is uncertain in adhesive results and clumsy to a degree. I have a mechanical device made by myself which will feather any arrow perfectly but any mechanical device requires so many different manipulations that it appeals only to those who lack the skill required to do the work properly without mechanical aids. The best plan for the

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skilled workman is to simply pick up the feather, apply glue to the contact surface of the bone, and stick it in position, but the knack only comes with long, patient practice and is fully as difficult as is the foregoing statement simple. For the benefit of advanced arrow makers, I beg to state, however, that it is the best way to feather arrows, and from every viewpoint it is the best. It requires no preparatory manipulation of the feather, the result is satisfying, and operation brief. I might say that in feathering my first arrows I resorted to the plan of wrapping them on with thread which held them in position while the glue dried. It required 2 hours to feather a single arrow and the result was anything but satisfactory. Years afterward on one occasion, by following the plan of simply "sticking them on," I feathered an even dozen arrows in thirteen minutes.

For the purpose of this article and of those for whose benefit it is written, I assert the following method of attaching the feathers to the shaft to be the best. If instructions have been followed to date the bone of the wing will extend at right angles from the vane about $\frac{1}{40}$ of an inch and the thickness of the

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bone at the point of contact with the shaft described as "A," will be about the same. The bone will extend beyond each end of the vane ⅛ of an inch. A supply of bead-headed steel pins about 1¼ inches in length should be secured. One pin is passed through the extension of the bone at the nock end of the vane, the point of the pin barely passing through the bone. Another pin is passed $\frac{1}{16}$ of an inch through the extension of bone on the opposite or pile end of the vane, but instead of being at right angles with the axis of the bone as is the first pin, it is placed at an angle of about 45 degrees, slanting toward the nock end of the vane. The glue is then applied in small quantities to the surface of the bone which will rest upon the shaft, in doing which a small sliver of wood serves the purpose better than a brush. The cock feather, being the one which is placed at right angles with the string notch, is the first to be applied and so placed that the distance between the extreme nock end of the shaft and the end of the vane is 1⅛ inches. While held in that position pin number 1 is pressed home. This will necessitate pressing the pin into the fibre nock,

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but that may be readily done. Pin number 2, which has been hanging in the loose end of the bone, is than grasped, the feather drawn taut and the point of pin number 2, which protrudes through the bone $\frac{1}{16}$ of an inch, is pressed slightly into the shaft, being careful still to retain the 45 degree angle. When the footing has been thus secured, pin number 2 is brought to a position at right angles with the axis of the shaft and pressed home. It will be noted that this operation secures a leverage which stretches the bone of the feather tight against the shaft and forces out any surplus glue. If the work is carefully performed there will be no surplus glue. The other two feathers are placed on the shaft in the same manner, being careful to accurately divide the total circumference of the shaft into three equal parts. This division may be made with the aid of instruments, laying off the different points of contact, but that is unnecessary labor. Practice will enable the workman to space those distances instantly by the eye and so accurately that they will not vary the distance of one of the holes made by the pin point. One hour is sufficient time to permit the drying of the

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glue, after which the pins are removed, the bone extension at the nock end is cut square, and the bone extension at the other end is trimmed to a feather edge with the feather knife.

The very best glue used for attaching the feathers is made of equal parts of the best commercial glue and Russian isinglass. Do not confuse isinglass with mica. The isinglass, after being cut with shears into small bits, is soaked for two days in sufficient water to cover it, together with the commercial glue, to which should be added brandy, quantity sufficient. It is then brought to a boil in an ordinary glue pot in a water bath. Brandy must be added from time to time as needed and small quantities of the glue cooked up as needed. Notwithstanding the use of brandy the glue ferments within a few days and gives off a very offensive odor. The Russian isinglass costs from 40c to 60c an ounce and may be secured from the large drug houses. It is, however, not expensive because of the great bulk in a given weight.

The entire arrow is next varnished from nock to pile with thin varnish, being careful to lay the varnish well over the glue joint

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formed by the union of the feather and shaft but keep it from coming into contact with the vane of the feather. If it does, the varnish will creep up the vanes, make them stiff and mar the looks. After this coat of varnish has thoroughly dried it is again cut down with the fine steel wool; the uniform weight of the arrows being maintained. The shaftment, being the space between a point $\frac{15}{16}$ of an inch from the extreme nock end to a point $4\frac{3}{4}$ inches from the extreme nock end is then painted any desired color, in doing which the paint is laid up, on and over the bone of the feather but not permitted to touch the vane. This is best done with a small round brush in which the bristles are about a half inch long, ending in a point. The crest is then painted on, using one wide band and several narrow ones or two or more wide ones, lined with a color different from any used in the crest. The lining is best done in a lathe but can be accomplished by laying the arrow in a notch cut in the work bench and twirling it with one hand while applying the paint lines with the other. For lining, I find a very fine pointed brush the easiest to handle. The band nearest the nock end is about $\frac{3}{16}$

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of an inch wide, leaving the final ¾ inch of the nock end bare of paint. The appearance is, however, fully preserved by the contrast between the wood of the shaft and the red fiber nock.

After the paint has dried the entire arrow is again varnished with a coat of varnish that has not been thinned, and after that has dried the arrow is again rubbed down with the fine steel wool and polished with a dry woolen cloth.

Hunting arrows are made of hickory 11/32 of an inch in diameter and 28 inches long. It is not necessary to foot them nor to reinforce the string notch with a nock. The feathers are stripped from the bone instead of being cut. Unless properly stripped, small particles of pith will adhere to the skin of bone that remains attached to the vane. To avoid this, take the feather just as it leaves the bird, grasp it at the outer or vane end with thumb and finger of left hand, holding the feather in a vertical position. With the thumb and finger of the right hand tear the vane loose from the bone near the vane end and immediately turn the torn part downward making and maintaining a sharp angle be-

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tween the torn part of the vane and the bone of the feather, then pull downward; the vane will strip off the entire length of the feather and will come away clean. If too much of the bone-skin comes off with the vane, it may be trimmed with the shears. The vanes of a hunting arrow are 4 inches long and ⅞ of an inch high. The big softer feathers of the wing yield better vanes than do the primary or pointers. The vanes are attached in like manner as to a target arrow but if placed with a slight twist or spiral the flight of the arrow will probably be improved 50 per cent. Indeed I feather all my target arrows with the same twist or spiral suggested for hunting arrows. If the pile end of the vane is placed 3/32 of an inch out of line with the axis of the shaft there will be ample twist to the vane. In fledging an arrow with spiral or twist wings, care must be taken to so place them that the pressure of the air on the vanes while in flight will come against what would be the nether side of the feather when in the wing of the bird, as the vane of a feather is very stiff in that direction while in the other it is limber.

Hunting arrows are headed according to

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the use intended. Babbitt headed blunt arrows are used in shooting at birds and small game in trees and sharp steel bladed ones for large game and game on the ground. The weight of hunting arrows should be as nearly uniform as practicable, but nothing like the great care in this respect is required as in the target arrow. They should be painted between the feathers and varnished to exclude moisture from shaft and vane. White feathers and a red shaftment have saved from oblivion many an honest shaft.

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